Measuring Ecosystem Restoration Benefits for Fish Passage/Dam Removal Projects

by

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Rock Island District

May 10, 2006

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Key Factors

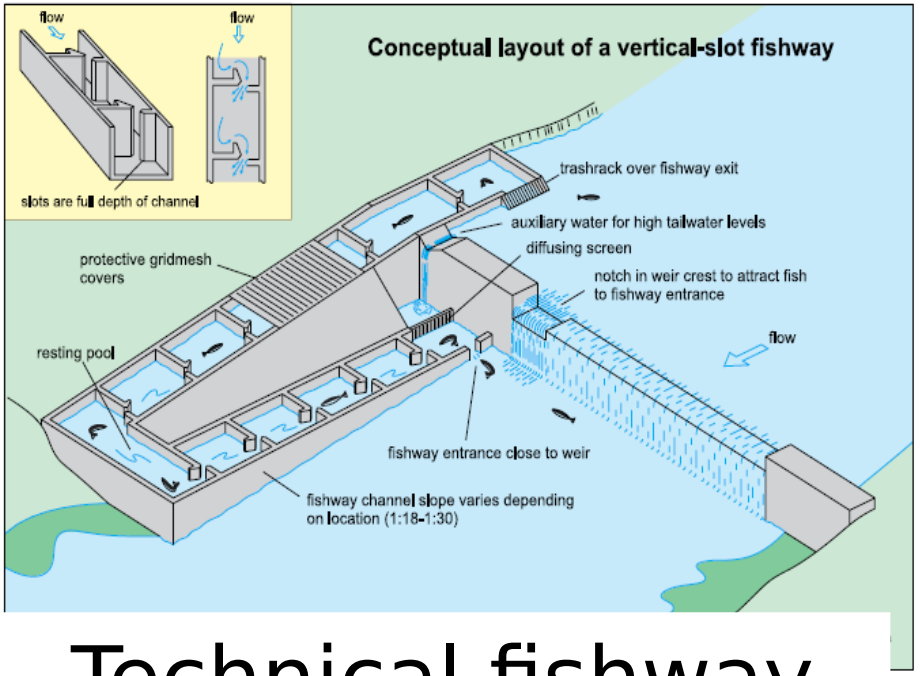
- Habitat Quantity
- Habitat Quality
- Passage Efficiency of Alternatives
- Optimizing benefits and addressing unintended effects

Examples from projects

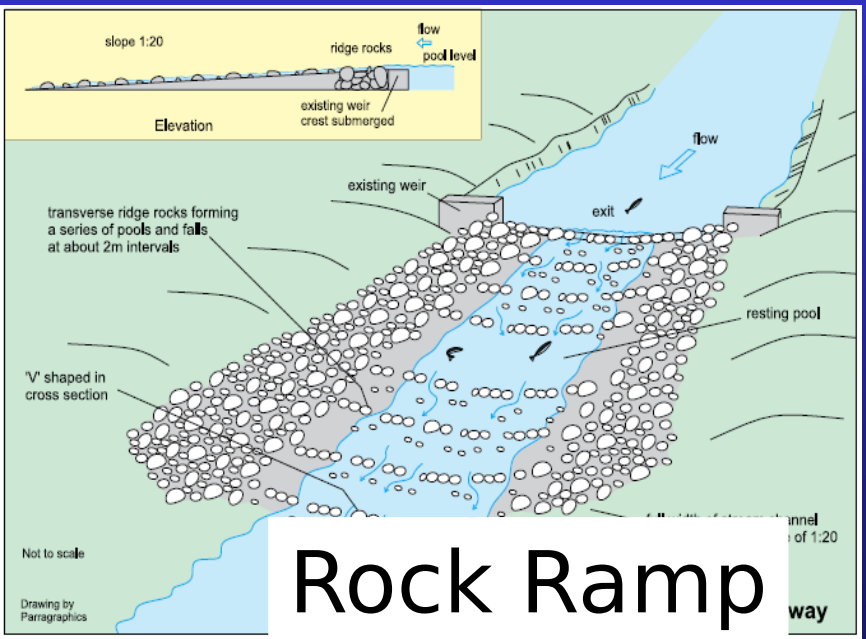
Why do fish move?

Midwest fish don't jump!

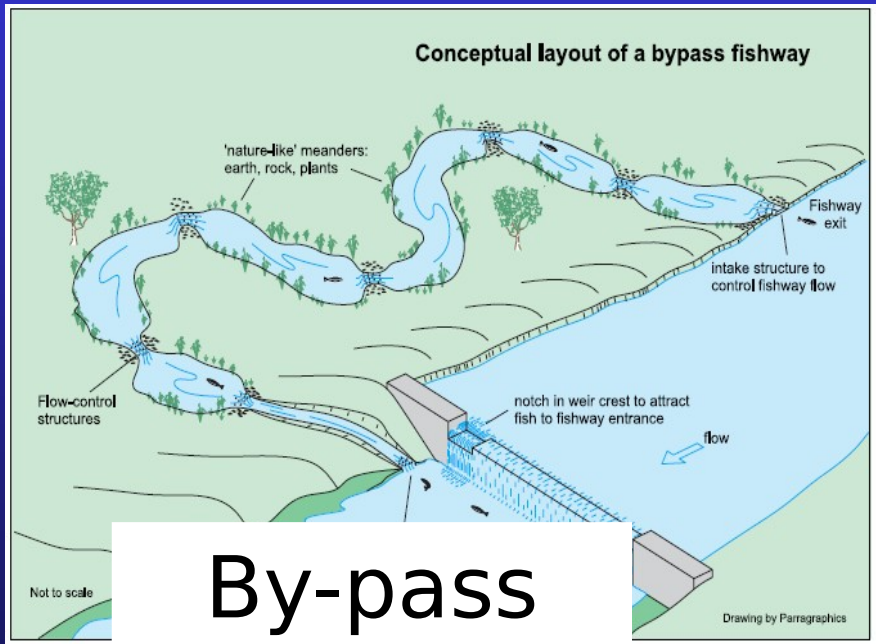
Dam removal


Conceptual layout of a vertical-slot fishway
flow
flow
slots are full depth of channel
trashrack over fishway exit
auxiliary water for high tailwater levels
diffusing screen
protective gridmesh covers
notch in weir crest to attract fish to fishway entrance
flow
resting pool
fishway entrance close to weir
fishway channel slope varies depending on location (1:18-1:30)

Technical fishway



Rock Ramp


Conceptual layout of a bypass fishway
'nature-like' meanders: earth, rock, plants
Fishway exit
intake structure to control fishway flow
Flow-control structures
notch in weir crest to attract fish to fishway entrance
flow
Not to scale
Drawing by Parragraphics

By-pass

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Key Factors for Evaluating Benefits

- Habitat Quantity
- Habitat Quality
- Efficiency of Passage
- How to optimize restoration plan when you have unintended ecological effects

Habitat Unit = Quantity x Quality

Quantity

- Connected Stream Miles
- Connected Acres
- Connected miles * Stream order

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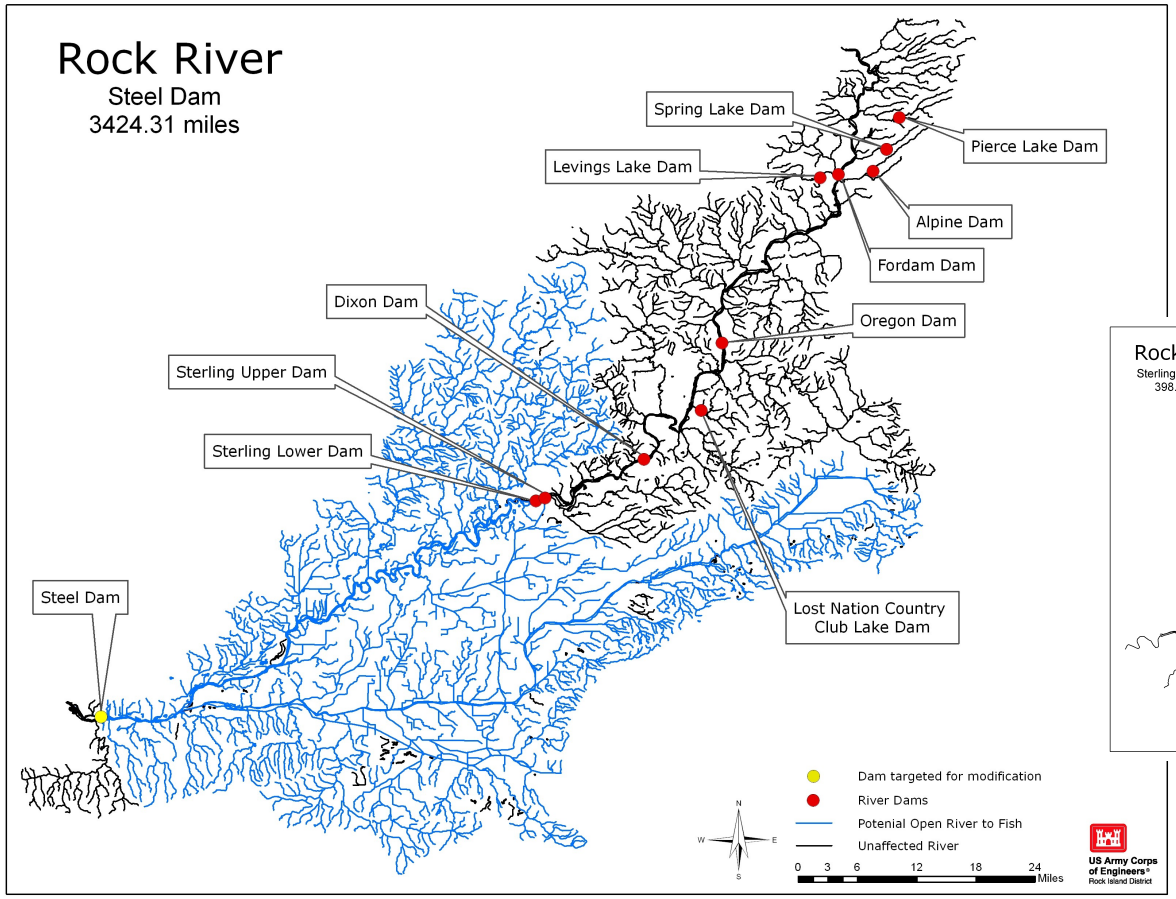
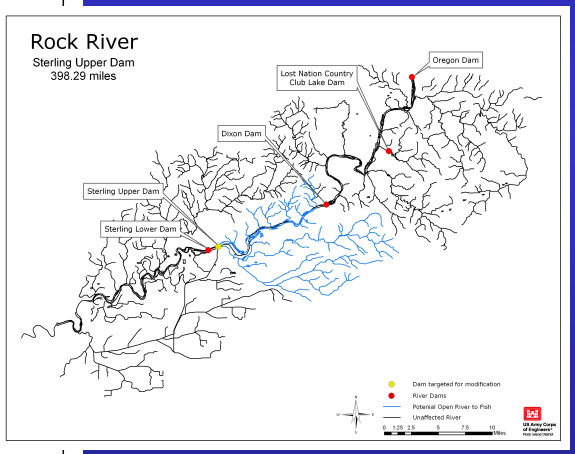
Rock River Example





1 dam
~3,400 stream miles

2 dams
~400 stream miles

One Team: Relevant, Ready, Responsive and Reliable

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UMRS Navigation Study Example

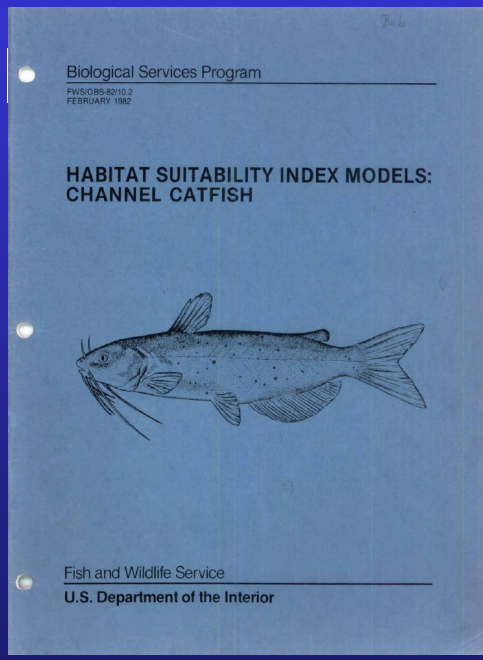
Longitudinal Connectivity Index

LCI = Σ (unobstructed stream length x stream order)

Pool 13	Connected Distance (miles)	Stream Order	Connectivity
Mill Creek	14.2	4	56.8
Maquoketa River	41.5	6	249
Apple River	13.1	5	65.5
Rush Creek	32.2	4	128.8
Plum River	39.4	5	197
Elk River	17.6	4	70.4
Pool 13 mainstem	55	9	495

Quality

- Habitat Suitability Indices for riverine species
- Qualitative Habitat Evaluation
- Index of Biotic Integrity
- Hydrogeomorphic Method



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Northeast example, Habitat Suitability Indices

Alternatives	River Fish HUs	Lake Fish HUs	Wetland HUs	Combined HUs
No Action	91	22	35	148
Dam Removal	202	9	6	217
Denil	152	23	35	210
Bypass	176	23	35	234

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Blackberry Creek, Quality Habitat Evaluation Index

- Developed by the Ohio EPA
- Correlates with the Index of Biotic Integrity
- Evaluates
  - substrate, instream cover, channel morphology, riparian zone, pool quality, riffle quality, map gradient

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HUs using QHEI

	QHEI	Distance	HU
Reach 1	64.8	1.22	79
Reach 2	32.4	5.5	178
Reach 3	55.3	0.6	33
		Total HUs	290

Passage Efficiency

Generally,

Removal > Rock Ramp > Bypass > Technical Fishway

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Passage Efficiency

Evaluate relative efficiency of different alternatives

- Best Professional Judgment, considering
  - Migration timing
  - H&H data
  - Fish swimming abilities
- Can fish find the entrance channel?
- Will there be flow in the channel during migration times?
- What about downstream passage?

Lock and Dam 3 Example
Passage Efficiency Index = Average P

Where P = Estimate potential for passage
(0= no potential, 5 = high potential)

	Passage Potential	
Species	**Alt 1**	**Alt 2**
Lake sturgeon	**0**	**4**
Paddlefish	**0**	**4**
Mooneye	**2**	**3**
Channel catfish	**0**	**3**
Smallmouth bass	**0**	**3**
	$\frac{2}{0.08} = \frac{2}{} =$	**$\frac{17}{0.68} = \frac{17}{} =$**

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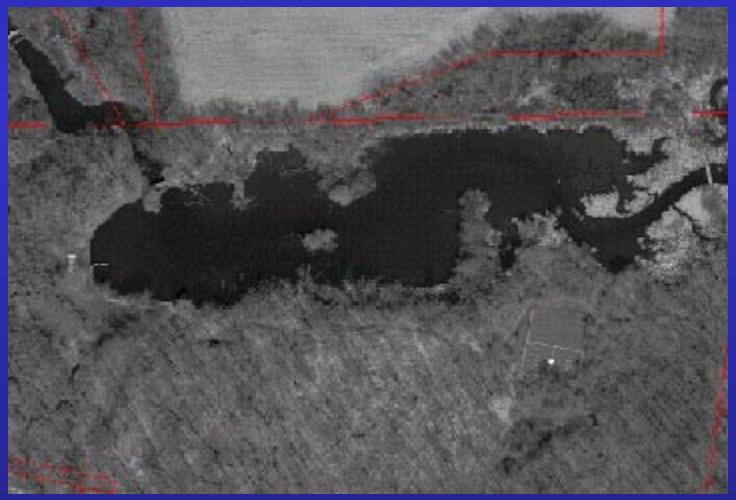
Passage Efficiency Index

	HU	Passage Efficiency	Total HUs
Alternative 1	**100**	**0.08**	**8**
Alternative 2	**100**	**0.68**	**68**

Habitat trade-offs



Dam removal

Loss of wetlands and lake habitat

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Blackberry Creek Example

0.8 acre wetland

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Blackberry Creek Example

Lose wetland, gain quality stream

- Lose 0.8 acres low quality wetland
- Out-of-kind mitigation for over 6 acres improved stream habitat

Regulatory coordination, to be determined …

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Trade-offs, Northeast Example

Alternatives	Cost	River Fish	Lake Fish	Wetland	Combined
No Action	$0	91	23	35	149
Dam Removal	$3,426	202	9	6	217
Denil	$982	152	23	35	210
Bypass	$890	176	23	35	234

Optimize on River Benefits

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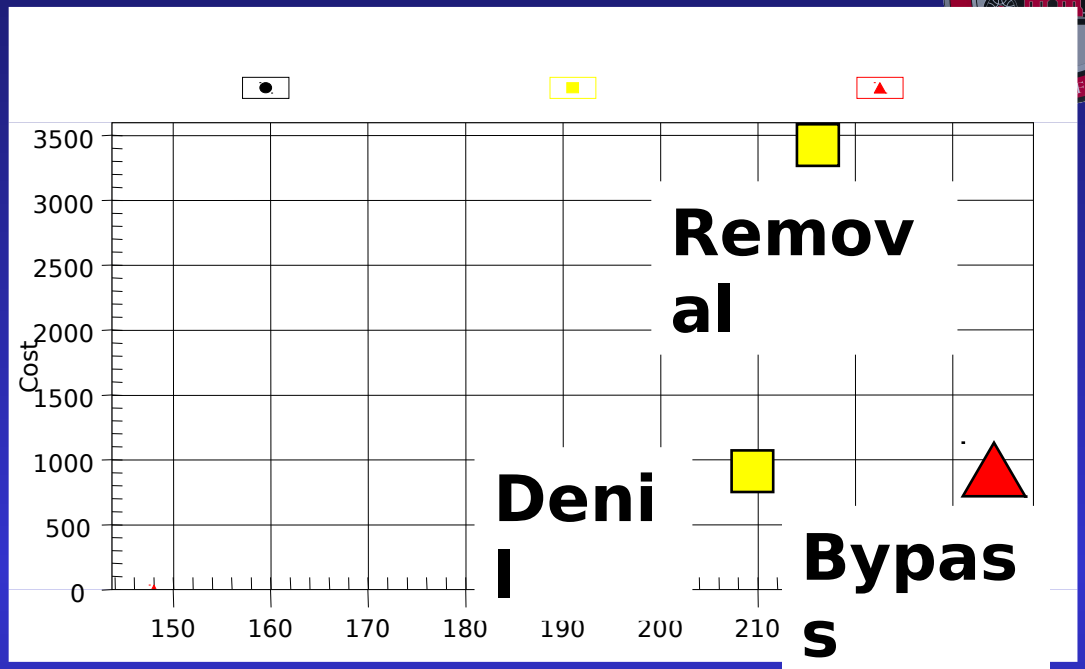
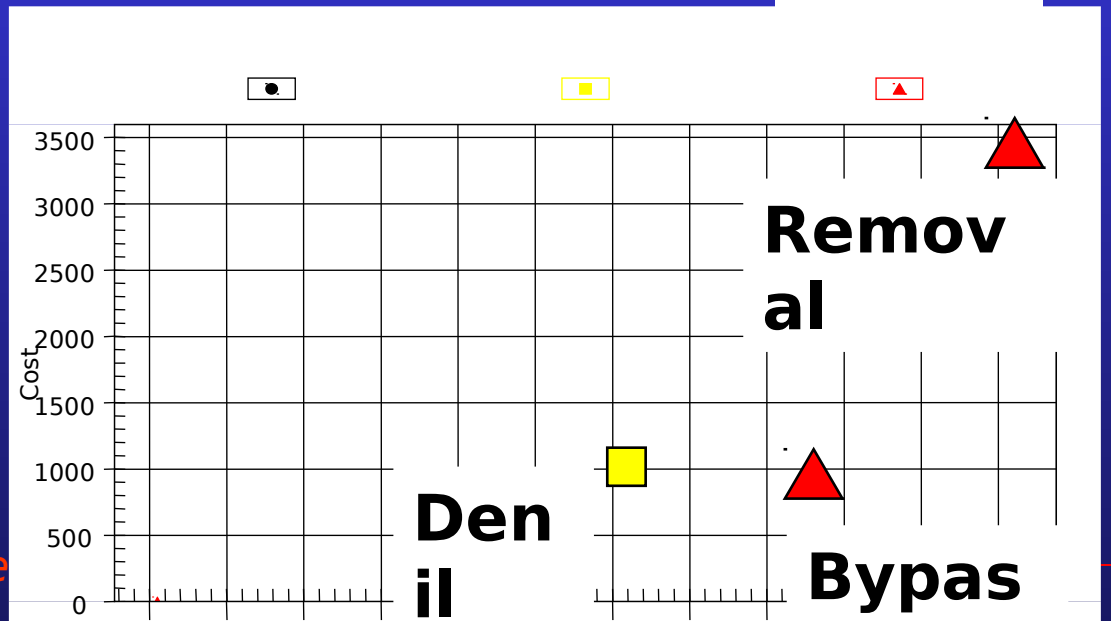
Combined outputs = River + Lake + Wetland



River outputs only



Take-away points

- Estimate the quantity and quality of habitat you are reconnecting
- Consider effectiveness of passage, now and with various alternatives
- Don’t underestimate the benefits of removal
- Deal with loss of lake and wetland habitat outside of CE-ICA

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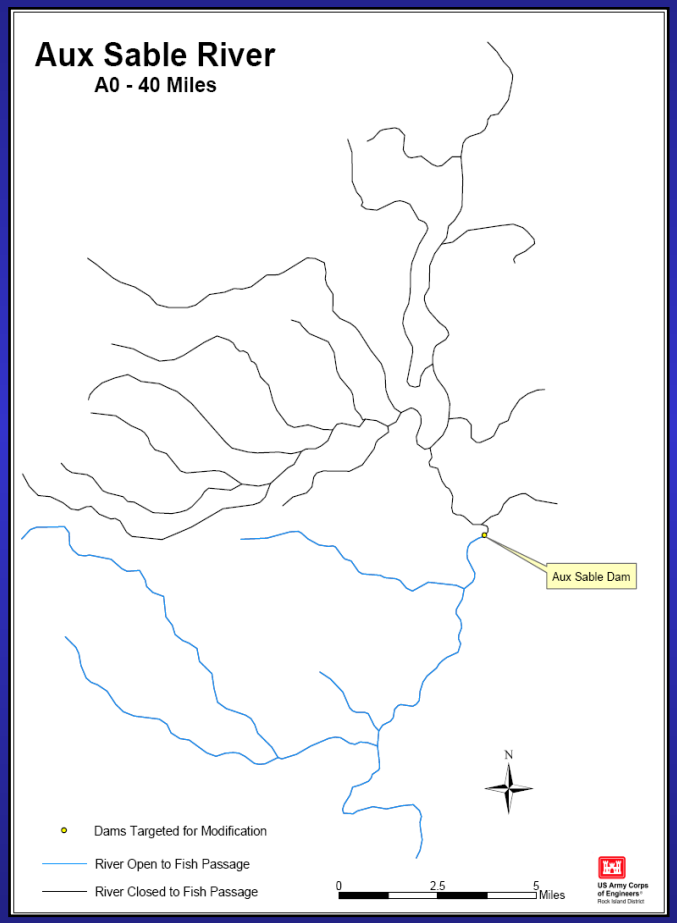
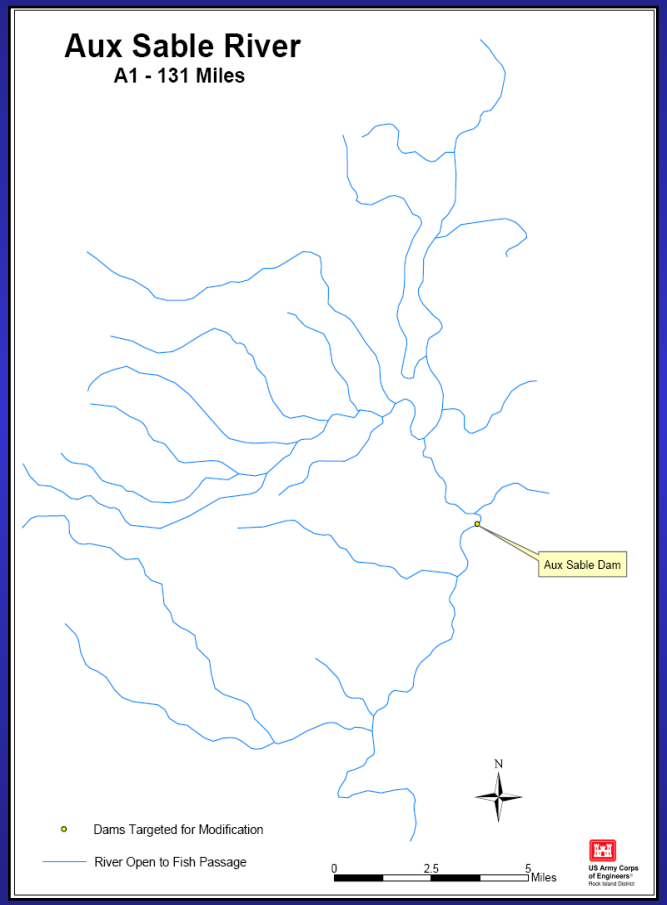
How much is reconnected?





40 connected miles

131 connected miles

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Why do we evaluate ecosystem benefits?

- Projects justified on non-monetary benefits
- Document significance of restoration
- Measure differences between alternatives
- Evaluation should characterize benefit and adverse effects

Better Decision-Making

Pool 13	Connected Distance (miles)	Stream Order	Connectivity
Mill Creek	14.2	4	56.8
Maquoketa River	41.5	6	249
Apple River	13.1	5	65.5
Rush Creek	32.2	4	128.8
Plum River	39.4	5	197
Elk River	17.6	4	70.4
Pool 13 mainstem	55	9	495
		TOTAL LCI	1262.5

UMRS Longitudinal Connectivity Index by Pool

Table 12
Longitudinal Connectivity Index for Each Navigation Pool of the UMRS (Pools shaded green have a high LCI, yellow moderate, and red have a low LCI)

Pool	1	2	3	4	5	5a	6	7	8	9
LCI	93	2669	845	2209	863	497	529	697	1110	1049
10	11	12	13	14	15	16	17	18	19	20
1978	1393	806	1263	1068	251	536	419	2113	2089	1513
					Illinois Waterway					
21	22	24	25	26	La Grange	Peoria	Starved Rock	Marseilles	Dresden	
1143	2576	1255	923	9982	5438	3997	228	641	284	

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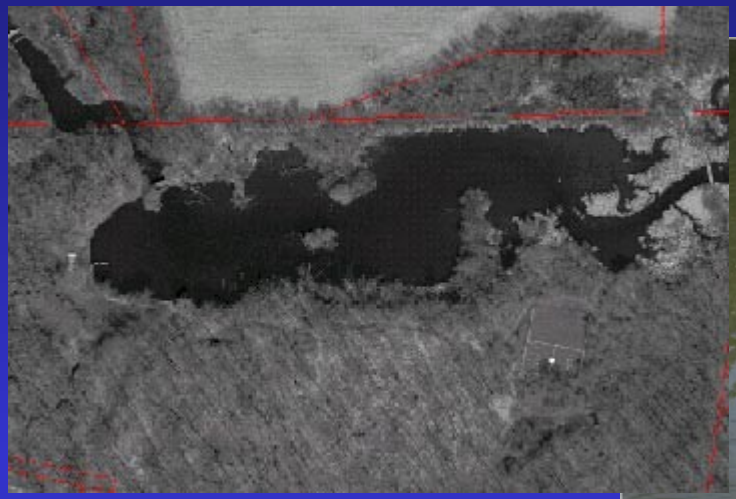
Alternatives

Alternatives

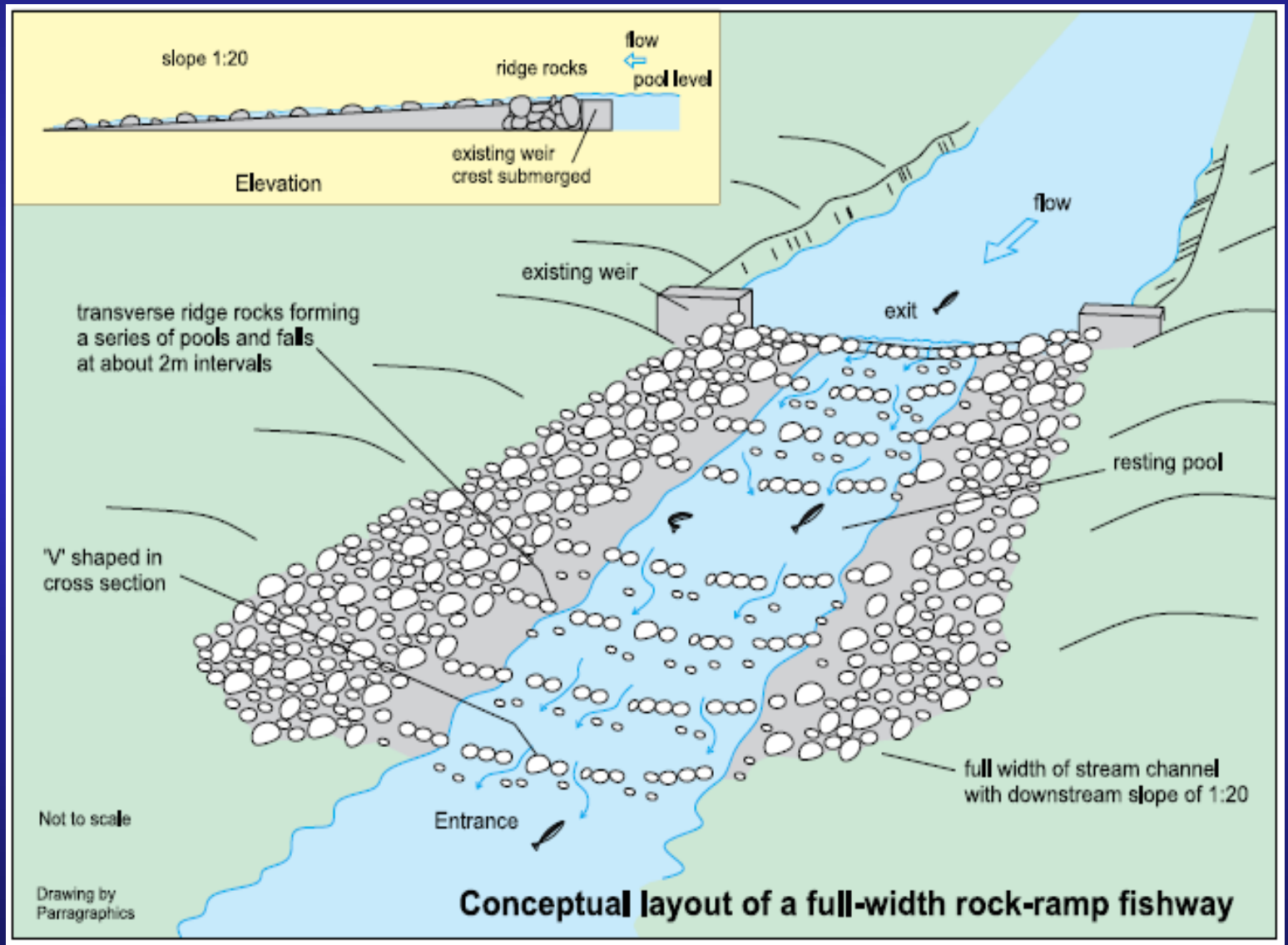
- Dam removal
- Rock ramp
- Nature-like bypass channel
- Technical fishway (Denil, vertical slot, etc.)

Dam Removal



Brewster Creek, Kane County, IL

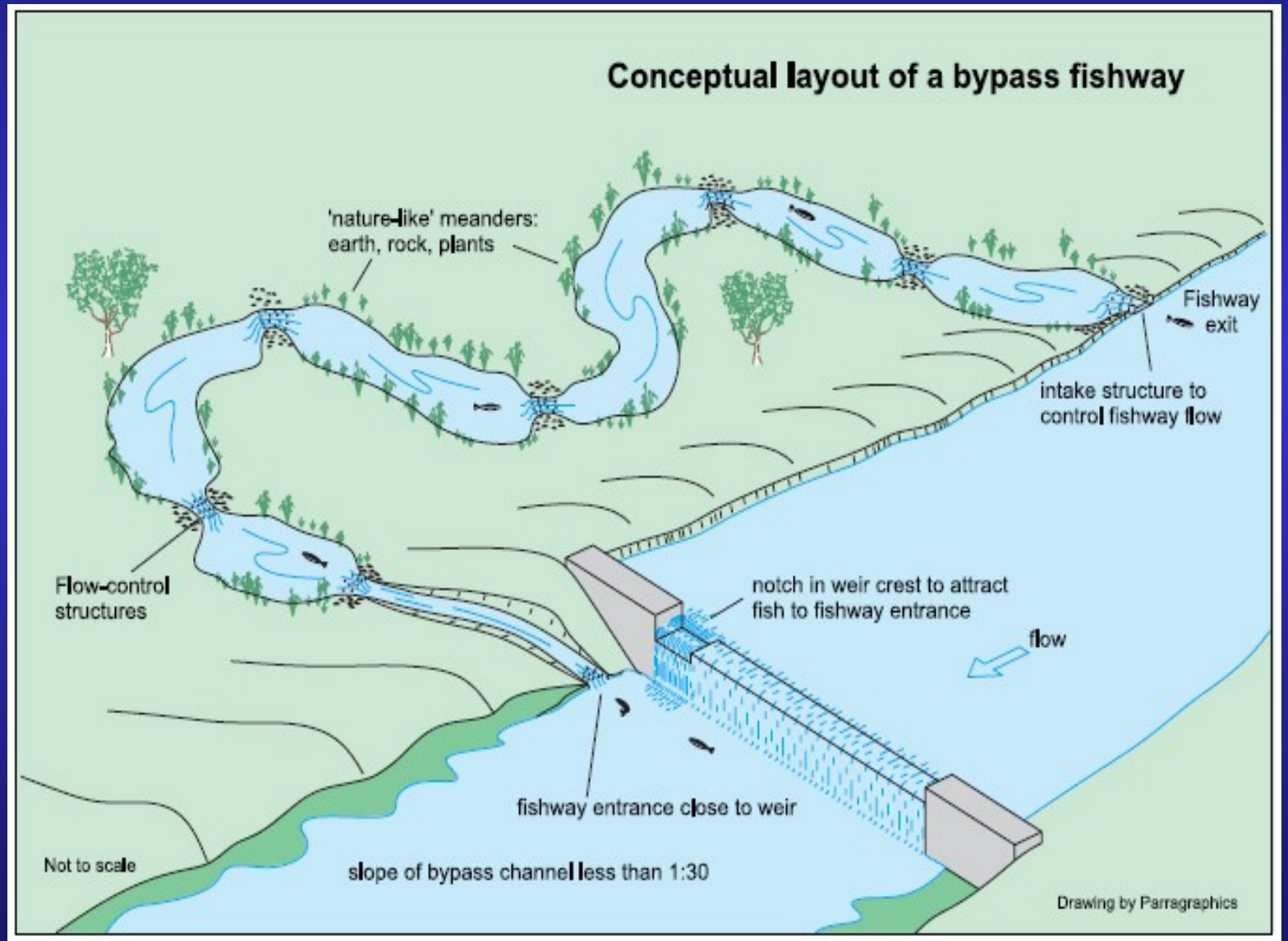
Rock Ramp


slope 1:20
ridge rocks
flow
pool level
existing weir
crest submerged
Elevation
flow
existing weir
exit
transverse ridge rocks forming
a series of pools and falls
at about 2m intervals
resting pool
'V' shaped in
cross section
full width of stream channel
with downstream slope of 1:20
Not to scale
Entrance
Drawing by
Parragraphics
Conceptual layout of a full-width rock-ramp fishway

Rock Ramp

Midtown Dam, Fargo, ND

Nature-like Bypass

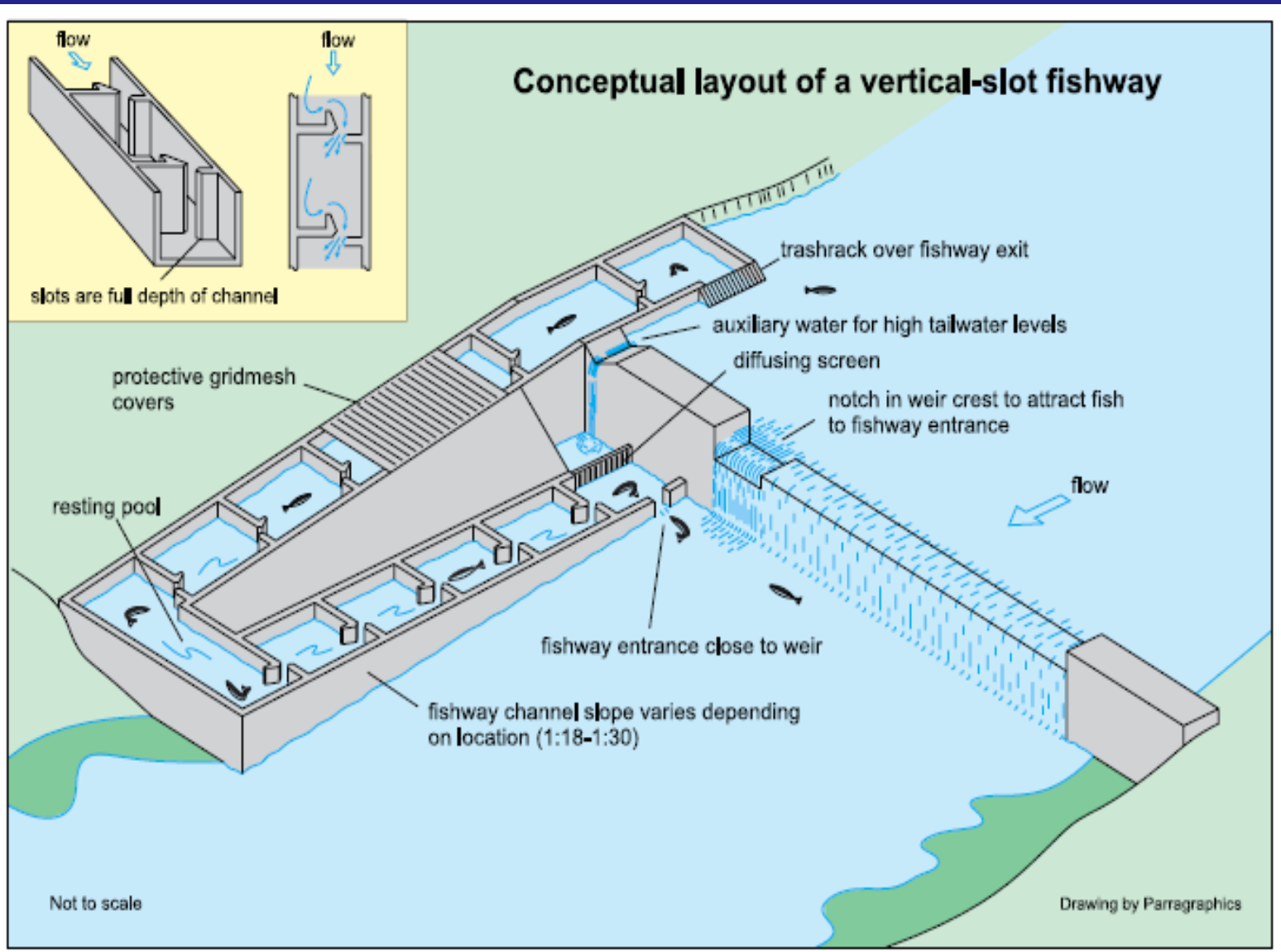


Nature-like Bypass

Nature-like Bypass

Fergus Falls, Red River of the North

Technical Fishway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